

Monroe Street Widening and Extension Phase 6, 9000 South to 9400 South
US DOT BUILD Grant Proposal

Benefit-Cost Analysis Technical Memorandum

EXECUTIVE SUMMARY

This Technical Memorandum serves as a supplement to the Benefit-Cost Analysis (BCA) Spreadsheet submitted as part of the Better Utilizing Investments to Leverage Development Transportation Discretionary Grants Program (the “BUILD Grants”). The grant application has been prepared by the City of Sandy, Hales Engineering, and Lewis Young Robertson Burningham, Inc. for funds to widen Monroe Street from 9000 South to 9400 South.

Sandy City has implemented a plan to improve Monroe Street between 9000 South (SR-209) and 10600 South. New segments have been constructed between 10000 South and 10600 South, and the segment between Towne Ridge Parkway to 10000 South has been widened to a five-lane cross section.

The next step in this corridor improvement is to realign Monroe Street between 9000 South (SR-209) and 9400 South. The new alignment will extend directly south from the 9000 South (SR-209) / Monroe Street intersection, replacing the existing Monroe Plaza Way, and connect to 9400 South at approximately 150 West. This alignment is shown in The Cairns Master Plan (CMP) adopted by the Sandy City Council on January 17, 2017. According to the CMP, Monroe Street is planned to consist of a five-lane cross section throughout.

The cost benefit of realigning Monroe Street between 9000 South (SR-209) and 9400 South, which includes the benefits from reduced travel distance, travel time, and NOx emissions, is anticipated to be approximately \$6,666.66 per day. Table 1 below further illustrates the costs and benefits.

Table 1	
Benefit-Cost Analysis Summary	
Figures discounted to 2017 Dollar	
Category	Present Value @ 7%
Project Cost	\$6,691,120
Project Benefits	
Travel Distance	(\$1,058,109)
Travel Time	\$15,885,808
NOx Emissions	(\$144,181)
Total Quantifiable Benefits	\$14,683,518
Net Cost/Benefit	\$7,992,398
Benefit-Cost Ratio	2.19

1.0 OVERALL METHODOLOGY

The BCA was documented in a spreadsheet format consistent with the requirements of the BUILD Grant program. This Technical Memorandum is a companion piece to the calculations and assumptions that are presented in the BCA Spreadsheet. It details the format and layout of the BCA Spreadsheet, the methodology used to calculate costs and benefits, and the assumptions, limitations, and application of the results.

Data was gathered from previously collected data from all available sources. These sources include:

- Previous traffic studies completed by Hales Engineering;
- Traffic studies completed by UDOT;
- AADT values published by UDOT; and
- Intersection turning-movement counts collected by the UDOT Automated Traffic Signal Performance Metrics (ATSPM).

This data was compiled and used to estimate existing evening peak-hour traffic conditions as shown in Figure 1 of the Appendix.

Future (2040) forecasted volumes were obtained from the Wasatch Front Regional Council/Mountainland Association of Governments travel demand model. Peak period turning movement counts were estimated using NCHRP 255 methodologies which utilize existing peak period turn volumes and future AWDT volumes to project the future turn volumes at the major intersections assuming that roadway alignments remain the same. Future (2040) no-build evening peak hour turning movement volumes are shown in Figure 2 in the Appendix.

The analysis also estimated turning movement counts for the future (2040) build conditions of Monroe Street realignment. These turning movement volumes are shown in Figure 3 of the Appendix.

Discount Rates

In accordance with OMB Circular A-94, the analysis uses a real discount rate of 7 percent per year to discount streams benefits and costs to their present value in their BCA.

Analysis Period

The analysis period covers of the full development and construction period of the project, plus 20 years after the completion of construction during which the full operational benefits and costs of the project are reflected in the BCA.

Development of this project began in 2013. Assuming funding becomes available in 2019, the development and construction of the project would be completed by June 2021. The analysis extends an additional 20 years, ending in 2041. The analysis period used in this BCA is, therefore, 29 years.

Base Case and Alternative Case Scenarios

The BCA needs to have a well-defined baseline against which to measure the incremental benefits and costs of the proposed project. For this project, the base case assumption assumes that the widening, realignment, and expansion of Monroe Street between 9000 and 9400 does not occur. The differences between the base case and alternative scenarios are illustrated in the Appendix.

2.0 CONSTRUCTION COST

The estimated construction cost to implement Phase 6 of the Monroe widening and extension project is \$11,192,899. The total project costs include the design and construction for the final phase of the project. The requested BUILD Grant funds represent the resources needed to complete the final phase of the project and will leverage the non-federal funding being provided by the state and other sources.

3.0 PROJECT BENEFITS

The following benefits or measures of effectiveness (MOEs) were analyzed:

- Travel Distance – total vehicle miles traveled within the study area;
- Travel Time – total vehicles hours traveled within the study area; and
- Nitrogen Oxides (NOx) Emissions – total vehicle NOx emissions from within the study area measured in short tons.

Despite additional MOEs being available, these were selected as they correspond to items in the U.S. Department of Transportation (USDOT) Benefit-Cost Analysis Guidance for Discretionary Grant Programs. The calculated MOEs for each condition are summarized in Table 2. Detailed more information is provided in the Appendix.

Table 2						
Sandy - Monroe Street BUILD Grant Application MOE						
Category	Future (2040) No Build Conditions	Future (2040) Build Conditions	Build vs. No Build	Monetized Values		Cost
Travel Distance (mi)	4008.6	4128.7	120.1	\$0.40	per mile	\$48.04
Travel Time (hr)	545.7	508.9	-36.8	\$14.10	per person-hour	\$(721.24)
NOx Emissions (ton)	0.01763696	0.01852432	0.00088736	\$7,377.00	per ton	\$6.55
Total					Peak-Hour Total	\$(666.66)
Source: Hales Engineering, July 2018						

As shown in Table 2, the total distance traveled and NOx Emissions within the study area during the peak hour are anticipated to increase with the realignment of Monroe Street. In accordance with the BCA Analysis' guidelines, this analysis treats these as negative benefits. The total travel time is anticipated to decrease, representing a clear benefit. The monetized values for each MOE were taken from the previously discussed USDOT document. The per person-hour value was calculated using a vehicle occupancy assumption of 1.39 persons per vehicle.

MOEs for no-build and build conditions were developed using Synchro/SimTraffic. Based on cost-benefit guidelines from USDOT, total peak-hour cost benefit for these MOEs is anticipated to be less than \$666.66 per day. Assuming that 10% of all daily traffic occurs during the evening peak hour, the daily cost benefit would be approximately **\$6,666.66 per day**.

QUALITY OF LIFE

This transportation project will provide benefits that cannot easily be monetized but nevertheless will improve the quality of life for the local residents and regional residents and visitors. Due to the availability of reliable data, the analysis only provides qualitative benefits to the project relating to the quality of life.

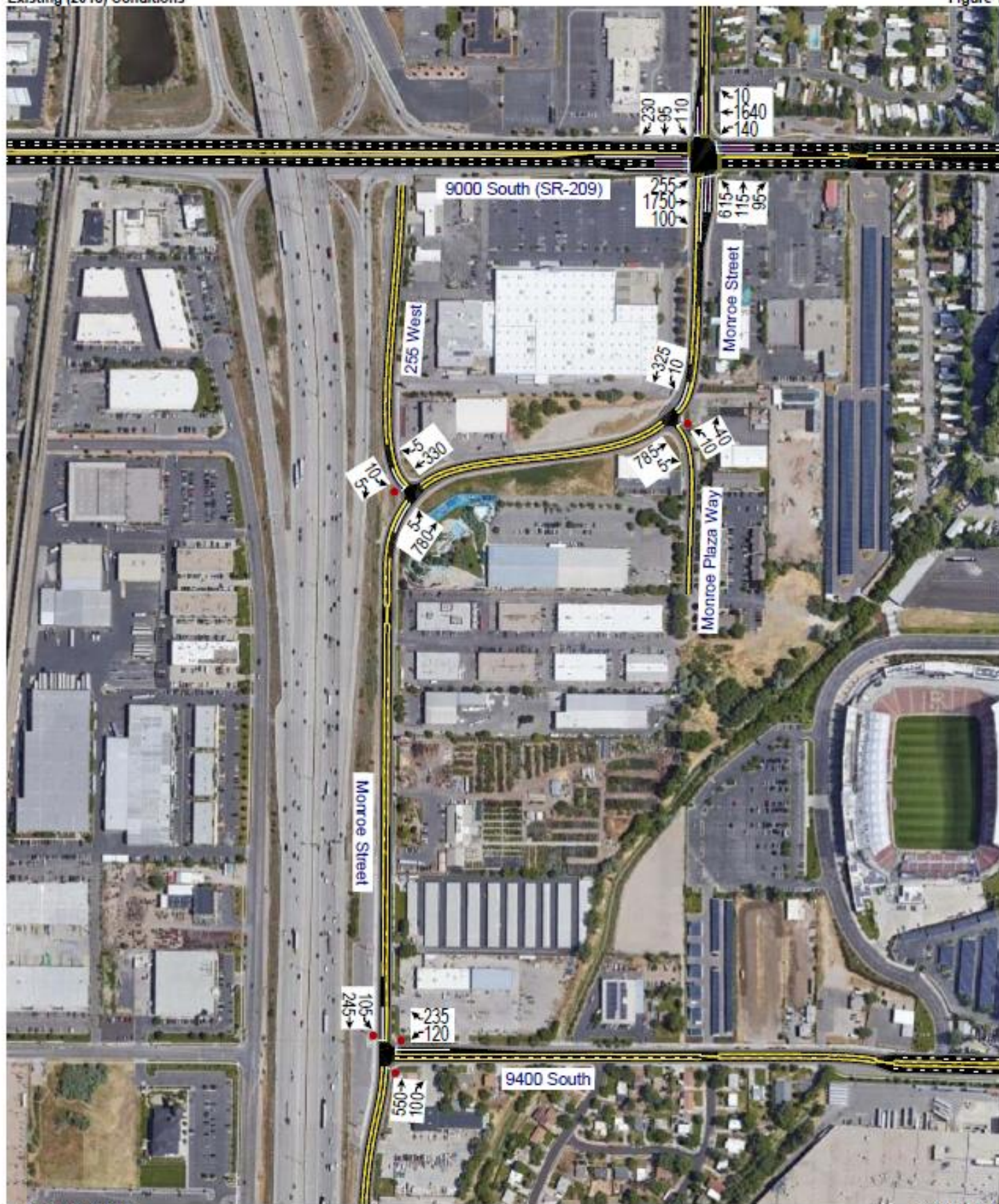
Once completed, the transportation improvement will more effectively move north/south traffic through this portion of the Cairns Downtown District adjacent to the Real Soccer Stadium. Improvements include bicycle lanes, wide pedestrian walkways and trails, on-street parking, and bus routes. These improvements will reduce congestion, increase the accessibility of the area, and improve the attractiveness of the area. While these benefits will likely increase the property value in the area, reliable data required for quantifying this benefit was unavailable.

4.0 PROJECT BENEFIT-COST RATIO

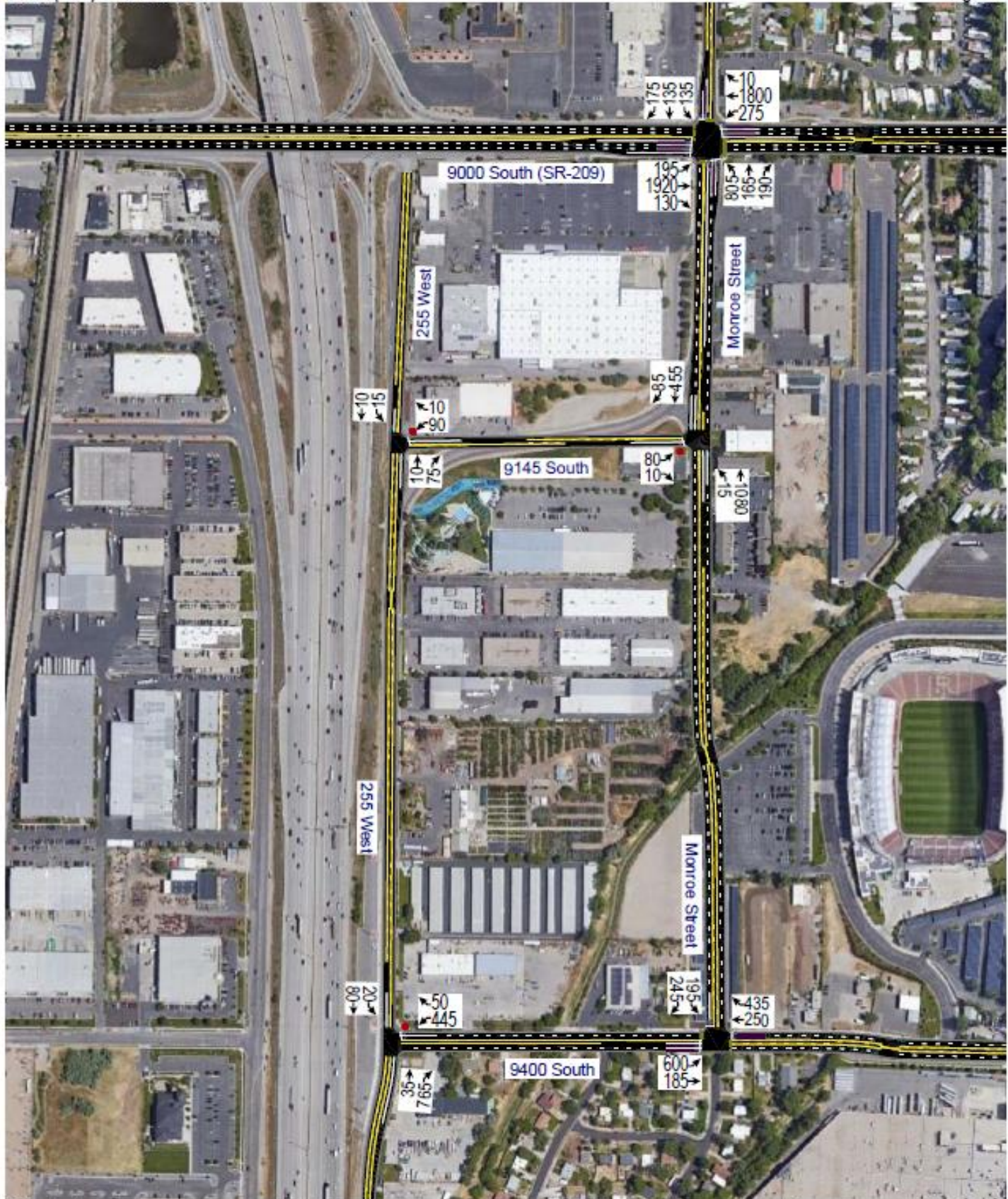
The following table summarizes the total project benefits and costs, including benefit-cost ratio. More details relating to the formulas, assumptions, and calculation are available in the Benefit-Cost Analysis' Spreadsheet file.

Table 3 Benefit-Cost Analysis		
Figures discounted to 2017 Dollar		
Category	Total	Present Value @ 7%
Project Costs		
Planning & Design	\$1,425,130	\$970,843
Construction	\$10,073,609	\$6,136,536
Total Costs	\$11,498,739	\$6,691,120
Project Benefits		
Travel Distance	\$(3,594,593)	(\$1,058,109)
Travel Time	\$53,967,022	\$15,885,808
NOx Emissions	\$(489,808)	(\$144,181)
Total Benefits	\$49,882,621	\$14,683,518
Net Cost/Benefit	\$38,383,882	\$7,992,398
Benefit-Cost Ratio	4.34	2.19

APPENDIX







1: Monroe Street & 9000 South (SR-209) Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Travel Dist (mi)	100.9	1017.1	70.1	9.4	65.0	0.3	88.4	19.1	21.9	13.4	12.7	17.2
Travel Time (hr)	7.6	74.9	4.4	21.0	96.0	0.5	23.1	4.3	3.5	3.7	3.2	2.4
Fuel Used (gal)	3.9	38.5	2.5	5.1	22.5	0.1	7.3	1.5	1.3	1.2	1.0	1.0
HC Emissions (g)	39	1970	35	17	719	0	48	14	12	9	6	10
CO Emissions (g)	899	31167	728	477	10223	6	1167	339	275	291	204	332
NOx Emissions (g)	110	4675	96	26	850	0	125	36	34	24	18	30

1: Monroe Street & 9000 South (SR-209) Performance by movement

Movement	All
Travel Dist (mi)	1435.4
Travel Time (hr)	244.4
Fuel Used (gal)	85.8
HC Emissions (g)	2878
CO Emissions (g)	46107
NOx Emissions (g)	6025

2: Monroe Street & Monroe Plaza Way Performance by movement

Movement	NWL	NWR	NET	NER	SWL	SWT	All
Travel Dist (mi)	1.3	4.7	130.7	1.5	2.2	75.2	215.6
Travel Time (hr)	0.5	1.7	8.7	0.1	0.1	3.1	14.3
Fuel Used (gal)	0.1	0.5	4.3	0.0	0.1	3.3	8.4
HC Emissions (g)	0	2	43	0	0	48	93
CO Emissions (g)	15	62	759	3	24	1324	2187
NOx Emissions (g)	1	5	109	0	3	166	284

3: Monroe Street & 255 West Performance by movement

Movement	SEL	SER	NEL	NET	SWT	SWR	All
Travel Dist (mi)	2.3	1.8	0.6	61.1	76.3	1.7	143.8
Travel Time (hr)	0.2	0.1	0.0	2.6	2.8	0.1	5.7
Fuel Used (gal)	0.1	0.0	0.0	1.7	2.2	0.0	4.1
HC Emissions (g)	0	0	0	20	24	0	45
CO Emissions (g)	7	4	2	316	379	4	712
NOx Emissions (g)	1	1	0	53	64	0	120

4: Monroe Street & 9400 South Performance by movement

Movement	WBL	WBR	NBT	NBR	SBL	SBT	All
Travel Dist (mi)	16.6	40.0	42.6	11.8	49.2	77.1	237.3
Travel Time (hr)	6.5	27.0	138.7	36.1	2.7	4.0	215.0
Fuel Used (gal)	1.9	6.8	32.1	8.4	1.4	2.1	52.7
HC Emissions (g)	12	33	122	27	13	20	228
CO Emissions (g)	397	915	3085	752	239	341	5730
NOx Emissions (g)	33	60	107	25	36	52	313

Total Zone Performance

Travel Dist (mi)	4008.6
Travel Time (hr)	545.7
Fuel Used (gal)	225.9
HC Emissions (g)	6322
CO Emissions (g)	116997
NOx Emissions (g)	16000

Intersection: 1: Monroe Street & 9000 South (SR-209)

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	TR	L	L	T
Maximum Queue (ft)	420	1196	1202	1185	280	228	246	250	248	385	722	210
Average Queue (ft)	256	711	740	734	135	201	212	200	187	355	576	191
95th Queue (ft)	508	1226	1232	1221	340	236	261	281	292	447	851	275
Link Distance (ft)		2796	2796	2796							707	
Upstream Blk Time (%)											12	
Queuing Penalty (veh)											143	
Storage Bay Dist (ft)	280				190	215				185		95
Storage Blk Time (%)	1	38		47		35	32			52	73	15
Queuing Penalty (veh)	6	75		62		212	89			394	550	119

Intersection: 1: Monroe Street & 9000 South (SR-209)

Movement	NB	SB	SB	SB
Directions Served	R	L	T	R
Maximum Queue (ft)	151	208	379	185
Average Queue (ft)	50	128	165	109
95th Queue (ft)	129	209	312	197
Link Distance (ft)			502	
Upstream Blk Time (%)			0	
Queuing Penalty (veh)			0	
Storage Bay Dist (ft)	95	120		85
Storage Blk Time (%)	2	23	32	13
Queuing Penalty (veh)	14	71	100	36

Intersection: 2: Monroe Street & Monroe Plaza Way

Movement	NW	NE	SW
Directions Served	LR	TR	L
Maximum Queue (ft)	231	596	37
Average Queue (ft)	73	183	10
95th Queue (ft)	203	597	34
Link Distance (ft)	514	750	
Upstream Blk Time (%)		1	
Queuing Penalty (veh)		16	
Storage Bay Dist (ft)			100
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 3: Monroe Street & 255 West

Movement	SE	SE	NE	NE	B17	SW
Directions Served	L	R	L	T	T	TR
Maximum Queue (ft)	51	35	48	111	45	2
Average Queue (ft)	13	9	4	16	5	0
95th Queue (ft)	41	32	20	126	70	2
Link Distance (ft)	910		323		1254	750
Upstream Blk Time (%)				1		
Queuing Penalty (veh)				12		
Storage Bay Dist (ft)	65	100				
Storage Blk Time (%)	1	0	2			
Queuing Penalty (veh)	0	0	0			

Intersection: 4: Monroe Street & 9400 South

Movement	WB	WB	NB	SB	SB
Directions Served	L	R	TR	L	T
Maximum Queue (ft)	497	510	607	169	194
Average Queue (ft)	312	407	576	79	98
95th Queue (ft)	645	603	598	133	160
Link Distance (ft)			550	1254	
Upstream Blk Time (%)			100		
Queuing Penalty (veh)			0		
Storage Bay Dist (ft)			100		
Storage Blk Time (%)			3	7	
Queuing Penalty (veh)			11	15	

Zone Summary

Zone wide Queuing Penalty: 1926

1: Monroe Street & 9000 South (SR-209) Performance by movement

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Travel Dist (mi)	100.8	999.1	68.0	9.0	60.0	0.4	123.2	25.5	29.0	12.8	13.7	16.6
Travel Time (hr)	8.5	84.6	4.6	34.0	168.2	0.8	49.8	5.4	3.7	4.0	5.5	3.5
Fuel Used (gal)	3.9	38.8	2.4	8.0	37.7	0.2	14.1	1.8	1.5	1.3	1.6	1.2
HC Emissions (g)	41	2122	25	33	1123	0	79	12	17	10	10	11
CO Emissions (g)	1086	35312	736	798	15609	10	1976	338	409	295	280	343
NOx Emissions (g)	130	5113	87	37	1108	0	174	36	48	27	26	32

1: Monroe Street & 9000 South (SR-209) Performance by movement

Movement	All
Travel Dist (mi)	1458.0
Travel Time (hr)	372.6
Fuel Used (gal)	112.6
HC Emissions (g)	3483
CO Emissions (g)	57191
NOx Emissions (g)	6819

2: Monroe Street & 9145 South Performance by movement

Movement	EBL	EBR	NBL	NBT	SBT	SBR	All
Travel Dist (mi)	10.0	1.3	2.6	183.9	71.7	13.3	283.0
Travel Time (hr)	11.7	0.7	0.2	21.3	2.8	0.6	37.3
Fuel Used (gal)	3.0	0.2	0.1	8.7	3.1	0.5	15.6
HC Emissions (g)	16	0	0	72	45	9	143
CO Emissions (g)	455	29	19	1651	1410	272	3835
NOx Emissions (g)	27	2	2	204	147	28	409

3: 255 West & 9145 South Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBL	SBT	All
Travel Dist (mi)	13.5	0.2	1.5	0.9	6.4	2.4	1.7	26.4
Travel Time (hr)	0.8	0.0	0.1	0.1	1.6	0.4	0.1	3.0
Fuel Used (gal)	0.5	0.0	0.1	0.0	0.4	0.1	0.0	1.2
HC Emissions (g)	6	0	0	0	3	0	0	10
CO Emissions (g)	141	1	7	7	62	11	4	234
NOx Emissions (g)	19	0	1	1	5	1	1	27

4: 255 West & 9400 South Performance by movement

Movement	WBL	WBT	WBR	NBT	NBR	SBL	SBT	All
Travel Dist (mi)	76.9	0.0	9.6	3.6	79.1	4.7	18.8	192.7
Travel Time (hr)	5.2	0.0	0.4	0.1	4.6	0.2	0.6	11.3
Fuel Used (gal)	3.1	0.0	0.4	0.1	1.8	0.1	0.5	6.0
HC Emissions (g)	34	0	6	2	21	1	8	72
CO Emissions (g)	1054	0	185	61	492	20	119	1931
NOx Emissions (g)	114	0	19	5	47	3	21	209

5: 9400 South & Monroe Street Performance by movement

Movement	EBL	EBT	WBT	WBR	SBL	SBT	SBR	All
Travel Dist (mi)	105.0	32.8	10.7	18.4	29.4	2.0	35.5	233.7
Travel Time (hr)	8.2	1.5	2.4	3.0	2.8	0.1	1.7	19.7
Fuel Used (gal)	5.0	1.5	0.9	1.0	1.1	0.1	0.9	10.5
HC Emissions (g)	69	26	6	7	7	1	9	125
CO Emissions (g)	2211	769	213	199	141	9	150	3693
NOx Emissions (g)	218	78	22	22	19	2	23	383

Total Zone Performance

Travel Dist (mi)	4128.7
Travel Time (hr)	508.9
Fuel Used (gal)	219.7
HC Emissions (g)	6796
CO Emissions (g)	127660
NOx Emissions (g)	16805

Intersection: 1: Monroe Street & 9000 South (SR-209)

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	TR	L	L	T
Maximum Queue (ft)	420	1823	1801	1763	280	225	250	249	248	750	839	831
Average Queue (ft)	266	918	931	898	127	205	208	190	177	643	687	525
95th Queue (ft)	527	1778	1760	1709	328	234	266	293	299	895	976	1034
Link Distance (ft)		2789	2789	2789							799	799
Upstream Blk Time (%)											26	16
Queuing Penalty (veh)											155	96
Storage Bay Dist (ft)	280				190	215				550		
Storage Blk Time (%)	1	44		49		46	35			53	57	35
Queuing Penalty (veh)	3	86		64		275	97			216	232	67

Intersection: 1: Monroe Street & 9000 South (SR-209)

Movement	NB	SB	SB	SB
Directions Served	R	L	T	R
Maximum Queue (ft)	210	210	519	185
Average Queue (ft)	104	130	262	125
95th Queue (ft)	211	225	531	223
Link Distance (ft)			502	
Upstream Blk Time (%)			7	
Queuing Penalty (veh)			0	
Storage Bay Dist (ft)	95	120		85
Storage Blk Time (%)	8	23	54	17
Queuing Penalty (veh)	14	71	170	45

Intersection: 2: Monroe Street & 9145 South

Movement	EB	EB	NB	NB	NB	B7	B7	SB	SB
Directions Served	L	R	L	T	T	T	T	T	R
Maximum Queue (ft)	320	693	288	715	688	36	24	2	4
Average Queue (ft)	168	215	34	276	252	3	1	0	0
95th Queue (ft)	392	747	191	804	771	31	20	2	3
Link Distance (ft)		812		882	882	785	785	799	
Upstream Blk Time (%)		12		2	2				
Queuing Penalty (veh)		11		11	8				
Storage Bay Dist (ft)	150		150					100	
Storage Blk Time (%)	44	0		31					
Queuing Penalty (veh)	5	0		5					

Intersection: 3: 255 West & 9145 South

Movement	WB	WB	NB	NB	B17	SB	SB
Directions Served	L	R	T	R	T	L	T
Maximum Queue (ft)	64	26	162	90	35	54	11
Average Queue (ft)	31	6	30	15	3	8	0
95th Queue (ft)	54	23	202	99	33	44	11
Link Distance (ft)		812	408		1254		777
Upstream Blk Time (%)			3				
Queuing Penalty (veh)			3				
Storage Bay Dist (ft)	150			100		65	
Storage Blk Time (%)			4	5		7	
Queuing Penalty (veh)			3	1		1	

Intersection: 4: 255 West & 9400 South

Movement	WB	WB	NB	SB
Directions Served	L	R	R	L
Maximum Queue (ft)	318	65	30	56
Average Queue (ft)	131	20	2	13
95th Queue (ft)	259	44	16	42
Link Distance (ft)	891	891		
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)			200	100
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 5: 9400 South & Monroe Street

Movement	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	T	T	T	TR	L	R
Maximum Queue (ft)	300	501	119	231	253	266	100
Average Queue (ft)	215	101	33	118	147	125	54
95th Queue (ft)	335	378	91	208	262	219	88
Link Distance (ft)		891	891			785	785
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)	100						
Storage Blk Time (%)	31	0					
Queuing Penalty (veh)	28	0					

Zone Summary

Zone wide Queuing Penalty: 1667